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|  | <b>INDIANA DEPARTMENT OF TRANSPORTATION</b><br>INTER-DEPARTMENT COMMUNICATION<br><i>Standards Section C Room N642</i> |  |
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November 16, 1999

**DESIGN MEMORANDUM No. 99-16**  
**TECHNICAL ADVISORY**

**TO:**            **All Design, Operations, and District Personnel, and Consultants**

**FROM:**        /s/ Richard L. VanCleave  
**Richard L. VanCleave**  
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**Contracts and Construction Division**

**SUBJECT:**     **New NCHRP 350 Bridge Railings and Transitions**

**EFFECTIVE:**   **May 23, 2000, Letting**

**I. INTRODUCTION**

Several new bridge railings and bridge railing transitions are available to the designer for use on appropriate highway projects. Which Performance Level (PL-\_\_) the railing and associated transition should meet may be determined by reviewing Section 49-9.0 of the INDOT Design Manual and Section IV of this Technical Advisory. The Performance Level terminology applies to the AASHTO *Guide Specifications for Bridge Railings*. Under the new NCHRP 350 criteria, performance of bridge railings and associated transitions is measured in terms of Test Levels (TL-\_\_). A bridge railing equivalency table for converting PL-1, PL-2, and PL-3 railings to TL-2, TL-4, and TL-5 railings is provided below.

**BRIDGE RAILING LEVEL EQUIVALENCY TABLE**

| TESTING CRITERIA                                | ACCEPTANCE EQUIVALENCIES |      |      |      |      |      |
|---|--------------------------|------|------|------|------|------|
| NCHRP Report 350                                | TL-1                     | TL-2 | TL-3 | TL-4 | TL-5 | TL-6 |
| AASHTO Guide Specifications for Bridge Railings |                          | PL-1 |      | PL-2 | PL-3 |      |

Details of the new bridge railings, bridge railing transitions, and guardrail transitions complying with NCHRP 350 criteria are now included in the respective metric and english standards. They are accessible via INDOT's internet home page at <http://www.state.in.us/dot/TS/standards/>

**II. TL-2 BRIDGE RAILINGS AND TRANSITIONS**

**A. RAILING, PF-2.** Joints in the concrete portion of this railing shall be located over the interior supports of a continuous span structure. The **Concrete Bridge Railing Transition, TPF-2**, must be used with this railing. The pay items are as follows:

Railing, PF-2 ..... m (LFT)  
Railing, Concrete, C ..... m3 (CYS)  
Reinforcing Steel, Epoxy Coated .....kg (LBS)  
Concrete Bridge Railing Transition, TPF-2.....EACH

The following standard drawings are required for this railing system.

| Metric      | English       |                                   |
|-------------|---------------|-----------------------------------|
| 706-BRPP-02 | E 706-BRPP-02 | Bridge railing details            |
| 706-BRPP-05 | E 706-BRPP-05 | Bridge railing details            |
| 706-BRPP-06 | E 706-BRPP-06 | Bridge railing details            |
| 706-TTBP-03 | E 706-TTBP-03 | Bridge railing transition details |
| 706-TTBP-04 | E 706-TTBP-04 | Bridge railing transition details |

**B. RAILING, PS-2.** Joints in the concrete portion of this railing shall be located over the interior supports of a continuous span structure. A sidewalk of 1500 mm (5 ft) minimum width is required with this railing. The **Concrete Bridge Railing Transition, TPS-2**, must be used with this railing. The pay items are as follows:

Railing, PS-2 ..... m (LFT)  
Railing, Concrete, C ..... m3 (CYS)  
Reinforcing Steel, Epoxy Coated .....kg (LBS)  
Concrete Bridge Railing Transition, TPS-2.....EACH

The following standard drawings are required for this railing system.

| Metric      | English       |                                   |
|-------------|---------------|-----------------------------------|
| 706-BRPP-04 | E 706-BRPP-04 | Bridge railing details            |
| 706-BRPP-05 | E 706-BRPP-05 | Bridge railing details            |
| 706-BRPP-06 | E 706-BRPP-06 | Bridge railing details            |
| 706-TTBP-07 | E 706-TTBP-07 | Bridge railing transition details |
| 706-TTBP-08 | E 706-TTBP-08 | Bridge railing transition details |

**C. RAILING, TX.** A sidewalk of 1500 mm (5 ft) minimum width is required with this railing. The **Concrete Bridge Railing Transition, TTX**, must be used with this railing. The pay items are as follows:

Railing, TX ..... m (LFT)  
Reinforcing Steel, Epoxy Coated .....kg (LBS)  
Concrete Bridge Railing Transition, TTX .....EACH

The following standard drawings are required for this railing system.

| Metric      | English       |                                   |
|-------------|---------------|-----------------------------------|
| 706-BRTX-01 | E 706-BRTX-01 | Bridge railing details            |
| 706-BRTX-02 | E 706-BRTX-02 | Bridge railing details            |
| 706-BRTX-03 | E 706-BRTX-03 | Bridge railing details            |
| 706-BRTX-04 | E 706-BRTX-04 | Bridge railing details            |
| 706-TTTX-01 | E 706-TTTX-01 | Bridge railing transition details |

**D. RAILING, TS-1.** Do NOT use this railing on the National Highway System. This railing is to be used only where federal and local funds or 100% local funds are involved, but not on an Intermodal Connector. The **Guardrail Transition, TGS-1**, must be used with this railing. The pay items are as follows:

Railing, TS-1 ..... m (LFT)  
Guardrail Transition, TGS-1 ..... EACH

For this railing system, the following recurring plan details must be incorporated into the plans.

706-B-140d Bridge railing details and Guardrail transition details

The appropriate metric or english version must be used.

### III. TL-4 BRIDGE RAILINGS AND TRANSITIONS

**A. RAILING, PF-1.** Joints in the concrete portion of this railing shall be located over the interior supports of a continuous span structure. The **Concrete Bridge Railing Transition, TPF-1**, must be used with this railing. The pay items are as follows:

Railing, PF-1 ..... m (LFT)  
Railing, Concrete, C ..... m3 (CYS)  
Reinforcing Steel, Epoxy Coated.....kg (LBS)  
Concrete Bridge Railing Transition, TPF-1.....EACH

The following standard drawings are required for this railing system.

| Metric      | English       |                                   |
|-------------|---------------|-----------------------------------|
| 706-BRPP-01 | E 706-BRPP-01 | Bridge railing details            |
| 706-BRPP-05 | E 706-BRPP-05 | Bridge railing details            |
| 706-BRPP-06 | E 706-BRPP-06 | Bridge railing details            |
| 706-TTBP-01 | E 706-TTBP-01 | Bridge railing transition details |
| 706-TTBP-02 | E 706-TTBP-02 | Bridge railing transition details |

**B. RAILING, PS-1.** Joints in the concrete portion of this railing shall be located over the interior supports of a continuous span structure. A sidewalk of 1500 mm (5 ft) minimum width is required with this railing. The **Concrete Bridge Railing Transition, TPS-1**, must be used with this railing. The pay items are as follows:

Railing, PS-1 ..... m (LFT)  
Railing, Concrete, C ..... m3 (CYS)  
Reinforcing Steel, Epoxy Coated.....kg (LBS)  
Concrete Bridge Railing Transition, TPS-1.....EACH

The following standard drawings are required for this railing system.

| Metric      | English       |                                   |
|-------------|---------------|-----------------------------------|
| 706-BRPP-03 | E 706-BRPP-03 | Bridge railing details            |
| 706-BRPP-05 | E 706-BRPP-05 | Bridge railing details            |
| 706-BRPP-06 | E 706-BRPP-06 | Bridge railing details            |
| 706-TTBP-05 | E 706-TTBP-05 | Bridge railing transition details |
| 706-TTBP-06 | E 706-TTBP-06 | Bridge railing transition details |

**C. RAILING, CF-1.** The **Guardrail Transition, TGT**, must be used with this railing. The pay items are as follows:

Railing, CF-1 ..... m (LFT)  
Guardrail Transition, TGT ..... EACH

The following standard drawings are required for this railing system.

| Metric      | English       |                              |
|-------------|---------------|------------------------------|
| 706-BRTM-01 | E 706-BRTM-01 | Bridge railing details       |
| 706-BRTM-02 | E 706-BRTM-02 | Bridge railing details       |
| 601-TTGT-01 | E 601-TTGT-01 | Guardrail transition details |
| 601-TTGT-02 | E 601-TTGT-02 | Guardrail transition details |

**D. RAILING, COMMON 840 HEIGHT CONCRETE.** This is a currently used solid concrete bridge railing with the traffic side face conforming to the “F” shape. **Concrete Bridge Railing Transition, TBC**, must be used with this railing. The pay items are as follows:

Railing, Concrete, C ..... m3 (CYS)  
Reinforcing Steel, Epoxy Coated.....kg (LBS)  
Concrete Bridge Railing Transition, TBC.....EACH

The following standard drawings are required for this railing system.

| Metric      | English       |                                   |
|-------------|---------------|-----------------------------------|
| 706-BCBR-01 | E 706-BCBR-01 | Bridge railing details            |
| 706-BCBR-03 | E 706-BCBR-03 | Bridge railing details            |
| 706-BCBR-04 | E 706-BCBR-04 | Delineators for bridge railing    |
| 706-TTBC-01 | BR-1          | Bridge railing transition details |
| 706-TTBC-02 | BR-1          | Bridge railing transition details |
| 706-TTBC-03 | BR-1          | Bridge railing transition details |

#### IV. TL-5 BRIDGE RAILING AND TRANSITIONS

**RAILING, TRUCK 1170 HEIGHT CONCRETE.** This is a currently used solid concrete bridge railing with the traffic side face conforming to the “F” shape, but it is taller than the Common 840 Height Concrete Railing to better restrain trucks from penetrating the bridge rail. **Bridge Railing Transition, TBT**, must be used with this railing.

Section 49-9.0 of the INDOT Design Manual should be reviewed to determine where this bridge railing and the associated bridge railing transition should be used. The pay items are as follows:

Railing, Concrete, C ..... m3 (CYS)  
 Reinforcing Steel, Epoxy Coated.....kg (LBS)  
 Concrete Bridge Railing, Transition, TBT.....EACH

The following standard drawings are required for this railing system.

| Metric      | English       |                                   |
|-------------|---------------|-----------------------------------|
| 706-BCBR-02 | E 706-BCBR-02 | Bridge railing details            |
| 706-BCBR-03 | E 706-BCBR-03 | Bridge railing details            |
| 706-BCBR-04 | E 706-BCBR-04 | Delineators for bridge railing    |
| 706-TTBT-01 | E 706-TTBT-01 | Bridge railing transition details |
| 706-TTBT-02 | E 706-TTBT-02 | Bridge railing transition details |
| 706-TTBT-03 | E 706-TTBT-03 | Bridge railing transition details |

## V. PL-1 AND PL-2 BRIDGE RAILING PERFORMANCE LEVEL SELECTION

The detailed methodology for determining the bridge railing performance level selection where either a PL-1 or PL-2 bridge railing will be used is given below. The methodology has been adapted from the AASHTO publication *Guide Specifications for Bridge Railings*, 1989.

The performance level is selected based on the following:

1. **PL-1.** A PL-1 bridge railing is appropriate on local or collector roads where the daily truck volumes in the design year are less than or equal to those presented in Figures A or B, whichever applies.
2. **PL-2.** A PL-2 bridge railing is appropriate on bridges which meet the following:
  - a. where the criteria for the PL-1 are not met; and
  - b. the truck volumes in the design year are less than or equal to those presented in Figures 49-9A, 49-9B or 49-9C of the INDOT Design Manual, whichever applies.

Figures A and B apply directly to bridges on tangent, on level roadways, with deck surfaces approximately 10.5 m above the under structure ground or water surface, and with low-occupancy land use or shallow water under the structure. The truck volume used to determine the performance level should be the design year average annual daily truck volume.

For highway conditions that differ from those above, the truck volume should be adjusted by the correction factors in Figures 49-9D and 49-9E of the INDOT Design Manual. These correction factors are discussed in Section 49-9.01 of the INDOT Design Manual.

Each side of the bridge should be checked against the performance level criteria; this is especially important for those bridges on horizontal curves. If the PL-2 bridge railing is warranted on one side of the bridge, it should also be used on the other side.

## DIVIDED (RURAL/URBAN) NON-FREEWAYS

| Average Daily Truck Volume in Design Year |  |                     |      |      |      |      |     |
|---|--|---------------------|------|------|------|------|-----|
| % Trucks in Total AADT                    | Barrier Offset from Edge of Travel-way | Design Speed (km/h) |      |      |      |      |     |
|   |  | 50                  | 60   | 70   | 80   | 90   | 100 |
| 5% or less                                | 0 m – 2.1 m                            | 5900                | 2700 | 950  | 450  | 300  | 200 |
| 5% or less                                | > 2.1 m – 3.6 m                        | 9700                | 4150 | 1350 | 600  | 400  | 250 |
| 5% or less                                | > 3.6 m                                | 20550               | 8200 | 2100 | 850  | 500  | 300 |
| > 5% but < 10%                            | 0 m – 2.1 m                            | 4850                | 2700 | 1450 | 800  | 550  | 400 |
| > 5% but < 10%                            | > 2.1 m – 3.6 m                        | 7400                | 4000 | 1900 | 1050 | 750  | 500 |
| > 5% but < 10%                            | > 3.6 m                                | 13300               | 6600 | 2850 | 1400 | 950  | 600 |
| 10 % or more                              | 0 m – 2.1 m                            | 4600                | 2700 | 1700 | 1050 | 750  | 550 |
| 10 % or more                              | > 2.1 m – 3.6 m                        | 6900                | 4000 | 2250 | 1350 | 1000 | 700 |
| 10 % or more                              | > 3.6 m                                | 11950               | 6500 | 3300 | 1850 | 1300 | 900 |

*Note: If the average daily truck volume in the design year is less than that in the figure, a PL-1 bridge railing is warranted. Where greater, a PL-2 or PL-3 bridge railing must be used.*

### **THRESHOLD WARRANTS FOR PL-1/PL-2 BRIDGE RAILINGS (Use on Federal-aid funded local agency projects only)**

**Figure A**

## UNDIVIDED (RURAL/URBAN) ARTERIALS, COLLECTORS & LOCALS

| Average Daily Truck Volume in Design Year |  |                     |      |      |      |     |
|---|--|---------------------|------|------|------|-----|
| % Trucks in Total AADT                    | Barrier Offset from Edge of Travel-way | Design Speed (km/h) |      |      |      |     |
|   |  | 50                  | 60   | 70   | 80   | 90  |
| 5% or less                                | 0 m – 2.1 m                            | 4850                | 2150 | 700  | 300  | 200 |
| 5% or less                                | > 2.1 m – 3.6 m                        | 8400                | 3500 | 1050 | 450  | 250 |
| 5% or less                                | > 3.6 m                                | 18000               | 7100 | 1700 | 600  | 350 |
| > 5% but < 10%                            | 0 m – 2.1 m                            | 3800                | 2100 | 1000 | 550  | 350 |
| > 5% but < 10%                            | > 2.1 m – 3.6 m                        | 6150                | 3150 | 1450 | 750  | 500 |
| > 5% but < 10%                            | > 3.6 m                                | 11150               | 5400 | 2200 | 1000 | 650 |
| 10 % or more                              | 0 m – 2.1 m                            | 3600                | 2100 | 1200 | 700  | 500 |
| 10 % or more                              | > 2.1 m – 3.6 m                        | 5650                | 3150 | 1650 | 950  | 650 |
| 10 % or more                              | > 3.6 m                                | 9900                | 5200 | 2450 | 1300 | 850 |

*Note: If the average daily truck volume in the design year is less than that in the figure, a PL-1 bridge railing is warranted. Where greater, a PL-2 or PL-3 bridge railing must be used.*

### **THRESHOLD WARRANTS FOR PL-1/PL-2 BRIDGE RAILINGS (Use on Federal-aid funded local agency projects only)**

**Figure B**

## **VI. GENERAL CONSIDERATIONS**

The designer should seek input from the appropriate INDOT District before selecting the type of bridge railing to use on a project.

Beyond the limits of the guardrail transitions, the W-beam guardrail length should be calculated using Chapter 49 of the Design Manual. If the calculated length is less than or equal to 15.24 m (50 ft), use 8 spaces of W-beam guardrail at 1.905 m (6 ft 3 in.) spacing equal to 15.24 m (50 ft) as a minimum before attaching a guardrail end treatment.

## **VII. GUIDELINES FOR THE LOCATION OF CONCRETE BRIDGE RAILING TRANSITIONS**

General guidelines to aid the designer in deciding where to locate the previously discussed transitions are as follows:

The ideal treatment will be to always locate a transition along the reinforced concrete bridge approach. This will keep the deck drainage not collected in the deck drains from flowing down the spill slopes at the bridge corners causing erosion at the end bents. Where practical, intersecting drives and public road approaches located near the end of the structure should be relocated to permit this treatment. When intersecting drives/approaches cannot be relocated, the designer should consider the following alternate treatments, in order of preference:

1. Locate the concrete bridge railing transition on the bridge deck if the structure has integral end bents;
2. Locate the concrete bridge railing transition along the reinforced concrete bridge approach.

In no case should any of the concrete railing transitions be located on the bridge deck if a deck expansion joint is located between the bridge floor slab and the mudwall.

In extreme cases with severe space restrictions, it may be necessary to discuss alternate treatments with the Standards Section staff.

At this time, standard detail drawings for the above new concrete bridge railing transitions that can be used with the Guardrail Transition Type WGB are not available. Designers should include details of modified versions of the new concrete bridge railing transitions in the plans when intersecting drives or public road approaches cannot be relocated away from the end of the structure.

## VIII. SCHEDULE OF PAY ITEMS

Payment for the bridge railing and bridge railing transitions will be made under the following:

| Pay Item Code | Pay Item                                  | Metric Pay Unit Symbol<br>(English Pay Unit Symbol) |
|---------------|---|---|
| 706-06339     | Railing, PF-1                             | m (LFT)   |
| 706-06341     | Railing, PF-2                             | m (LFT)   |
| 706-06342     | Railing, PS-1                             | m (LFT)   |
| 706-06343     | Railing, PS-2                             | m (LFT)   |
| 706-06344     | Railing, TS-1                             | m (LFT)   |
| 706-06347     | Railing, CF-1                             | m (LFT)   |
| 706-06349     | Railing, TX                               | m (LFT)   |
| 706-06351     | Concrete Bridge Railing Transition, TPF-1 | EACH  |
| 706-06352     | Concrete Bridge Railing Transition, TPF-2 | EACH  |
| 706-06353     | Concrete Bridge Railing Transition, TPS-1 | EACH  |
| 706-06354     | Concrete Bridge Railing Transition, TPS-2 | EACH  |
| 706-06372     | Concrete Bridge Railing Transition, TTX   | EACH  |
| 601-02800     | Guardrail Transition, TGT                 | EACH  |
| 601-06374     | Guardrail Transition, TGS-1               | EACH  |
| 706-51020     | Railing, Concrete, C                      | m3 (CYS)  |
| 703-51032     | Reinforcing Steel, Epoxy Coated           | kg (LBS)  |